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Framework for Wetland Systems Management: Earth Sciences Perspective

PURPOSE: The capacity of wetlands to provide specific functions is inextricably linked to characteristics and processes of the surrounding landscape, and therefore effective wetland stewardship and management must operate within a landscape context. This technical note provides fundamental concepts for managing wetlands by summarizing a comprehensive and systematic framework for managing wetlands as interactive components of landscape systems (Warne and Smith 1995).

BACKGROUND: Effective wetland stewardship and management requires a thorough understanding of many wetland and landscape components and processes, and their interactions. Data sources and principles and methods for evaluating the climate, geology, and hydrology of landscape and wetland systems are described in Warne and Smith (1995). The framework presented here provides guidance for formulating and implementing a comprehensive wetland management program (Figure 1) in three principal phases: (1) plan formulation, (2) information development, and (3) program implementation. Procedures for carrying out these phases are briefly discussed below.

FORMULATING A MANAGEMENT PLAN (PHASE 1): A wetland management program begins by formulating a realistic and viable, yet flexible, monitoring and management plan that incorporates seven steps: (1) defining underlying management concerns, (2) assessing available resources, (3) establishing goals in the context of available resources, (4) determining the size of the landscape to be evaluated, (5) establishing an initial action plan that is capable of attaining prescribed goals, (6) organizing management teams, and (7) establishing an education program. In practice, development of many of these steps occurs simultaneously because decisions regarding procedures in one step are interrelated to those of other steps. Underlying management concerns involve mandates, criteria, regulations, orders, and environmental concerns that prompted development of the wetland management program. Management goals and practices are to be tailored to address these concerns.

A viable wetland management plan considers available resources of money, data, and personnel. This consideration cannot be overemphasized. If resources are not available, the program will fail. A simple but comprehensive plan is preferable to an elaborate plan that must later be curtailed. Early recognition of those phases of the program that are resource intensive (monitoring, data compilation, etc.), and evaluation of their cost in terms of time and money, serves as a basis for determining the scale and depth of detail of monitoring and analysis in the management program.

Goals incorporate, as appropriate, maintenance and enhancement of particular wetland functions, protection of certain fauna or flora, and objectives of environmental programs being carried out in the area by other federal, state, or local agencies. The overall goal, however, is to manage wetlands and their functions in a landscape context. Effective goals include a timetable that demarcates when specific tasks (collection, compilation and analysis of historical data, compilation of land cover and land use maps, etc.) are to be completed.

Defining the areal extent of the landscape to be monitored and analyzed begins by considering the drainage basin that contributes surface water flow to the wetland. The drainage basin is the fundamental unit for landscape evaluation. If the entire drainage basin is not to be evaluated, the landscape area

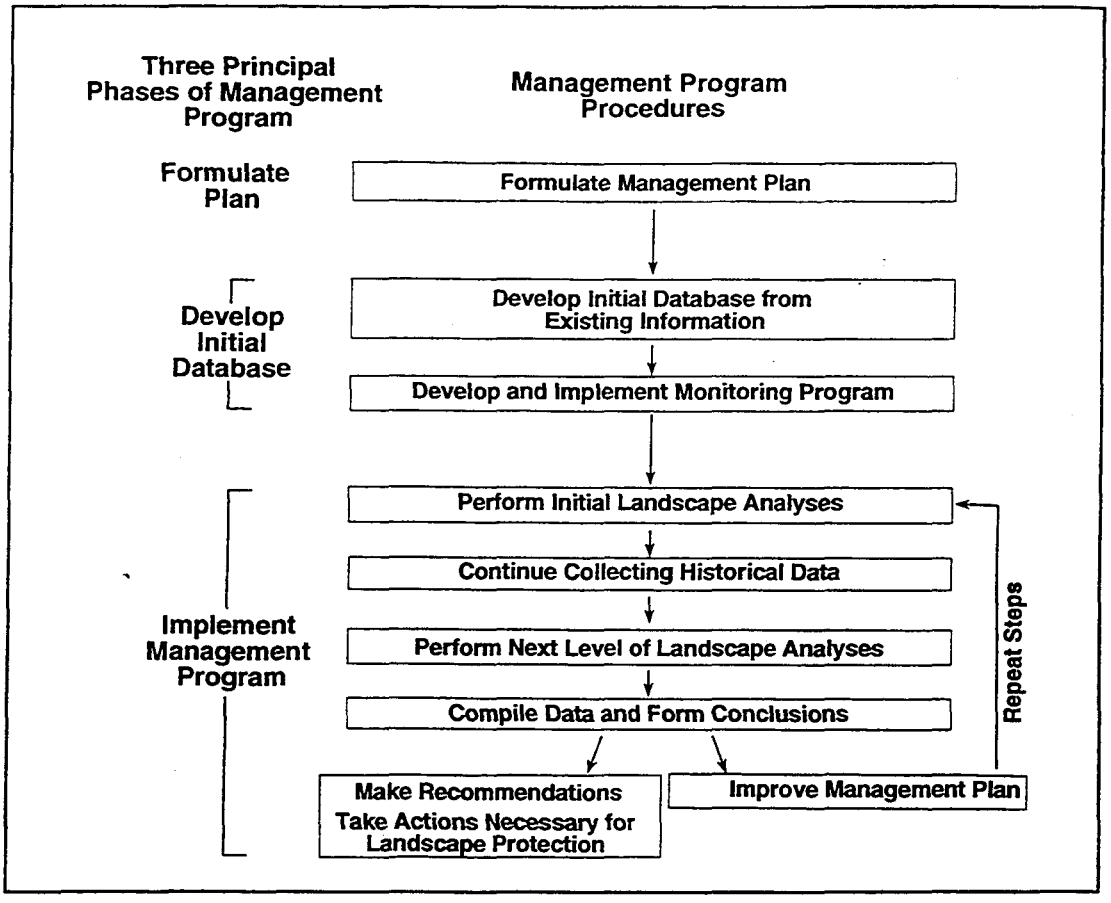

Figure 1. General framework for developing and implementing a wetland management program

should be a subbasin with clearly defined boundaries. Seaba, Kapinos, and Knapp (1987) provide guidelines for defining drainage basins and subbasins. In all cases, principal attributes of the entire drainage basin are considered (land use, land cover, position of the wetland in the watershed, etc.). In addition, regional- and national-scale observations are compiled and analyzed to monitor the effects of large-scale trends on landscape form and process.

An effective working plan is comprehensive, taking into account a broad range of atmospheric, geologic, hydrologic, and biologic aspects of the landscape. Essential elements of the plan include determining scales and resolution of analyses, type of data management and analysis systems to be used, initial data needs, and timetable of initial analysis (Figure 1). A flowchart similar to Figure 1 is a convenient and effective method to outline a working plan.

DEVELOPING AN INITIAL DATABASE (PHASE 2): Detailed assessment of data needs includes identifying relevant existing data and assessing their cost, quality, and applicability (Warne and Smith 1995). Resources should be allocated for ongoing data search, collection, and compilation of existing data. Priorities should be established that define the order in which data are to be acquired and compiled.

A monitoring program should be established after available data have been assessed and inventoried and the essential aspects of the landscape that lack data have been identified (Figure 1). Landscape-scale processes to be monitored may include precipitation, evapotranspiration, temperature, wind speed and

direction, sedimentation rates, stream discharge, groundwater movement, plant and animal diversity/abundance, and threatened and endangered species populations. As the management program evolves, the monitoring program may be enhanced. Therefore, monitoring systems such as piezometer nests should be arranged so that additional monitors can be placed in the relevant locations.

IMPLEMENTING THE MANAGEMENT PROGRAM (PHASE 3): After the initial data and the preliminary information from the monitoring program have been compiled, initial landscape analysis is conducted (Figure 1). The initial landscape analysis identifies serious problems that warrant immediate attention, such as water-level fluctuations that inhibit nesting or plant germination, sediment loadings that endanger vegetation or fish populations, and anomalously high nutrient levels. Initial analysis also identifies landscape-scale hydrologic and geomorphic processes critical to maintaining and enhancing specific wetland functions and evaluating landscape and wetland equilibrium states.

The landscape is reevaluated as additional data are compiled and analyzed or as management needs warrant (Figure 1). Information is summarized in the form of graphs and composite maps (see Warne and Smith 1995). Primary goals of the monitoring and analysis program are to promote understanding of the landscape's hydrologic and geomorphic systems (Figure 2), and the position and role of the wetland within these systems. Knowing these systems, one can identify critical hydrologic and geomorphic processes affecting wetland functions, landscape equilibrium, frequency and type of agents that cause significant changes in the wetland and landscape, and the impact of humans on the wetland.

With an understanding of process-response relationships within a landscape, an effective management strategy can be developed to consider the wetland as an integral part of the landscape. The management strategy should include periodic reevaluation of the current monitoring program. As management concerns change and understanding of the wetland landscape is enhanced, the goals of the program should be reassessed and modified (Figure 1).

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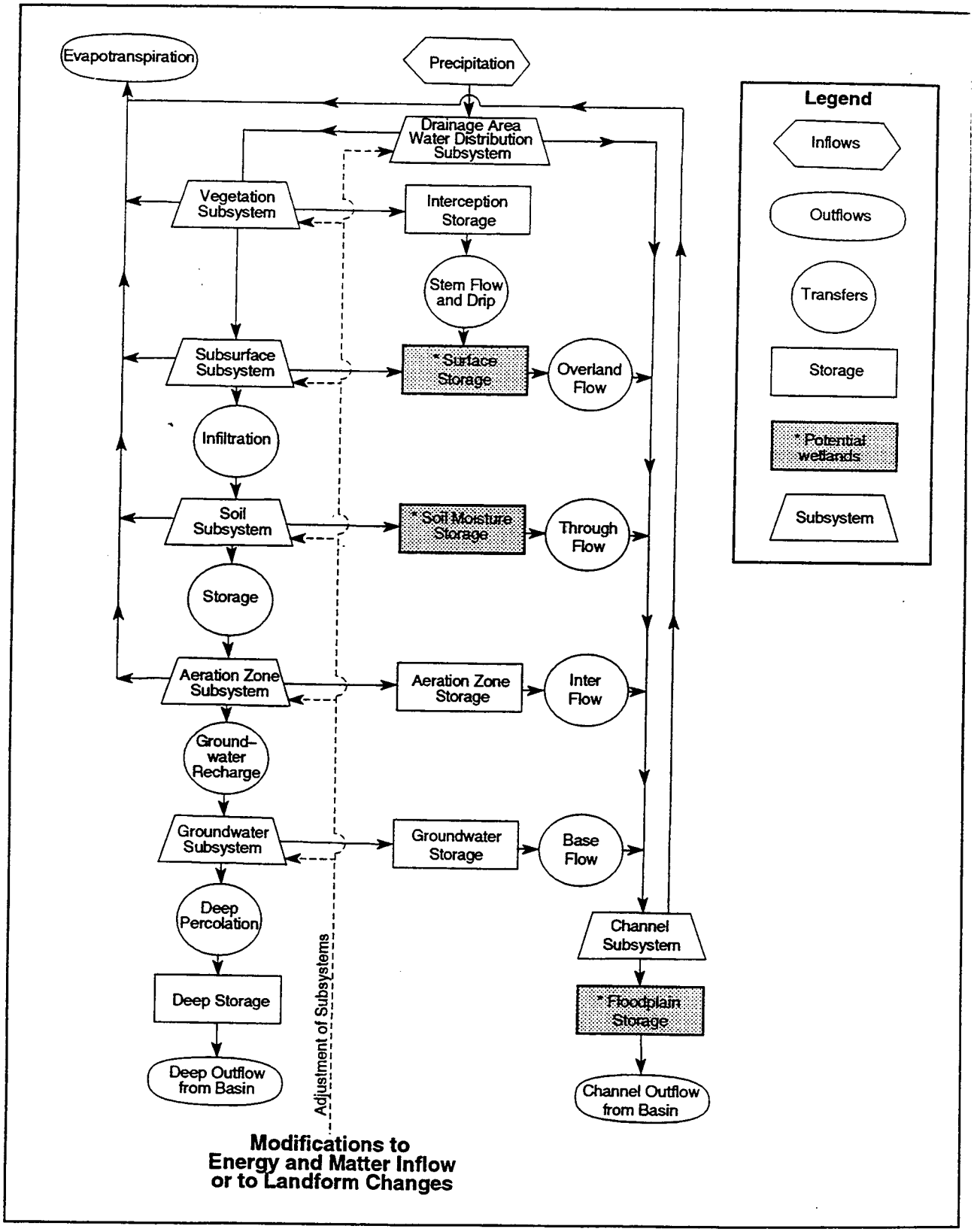

Figure 2. Schematic diagram showing basic exchanges and storages involved in a basin hydrologic cycle (after Chorley, Schumm, and Sugden 1985)